WE CLAIM:

CLAIMS

1. A swivel joint apparatus for supplying utilities to a rotating building rotatable about a central axis, comprising:

an inner, fixed spindle for securing to a fixed base of a rotatable building to extend co-axially with a central axis of rotation of the building, the spindle having a series of spaced, outwardly projecting annular flanges defining a series of annular chambers between each adjacent pair of flanges, each flange having an outer peripheral edge and at least one ring seal mounted on the peripheral edge of each flange, the flanges having a predetermined outer diameter;

an outer casing rotatably mounted on the spindle for securing to part of the rotating building, the casing having an inner diameter substantially equal to the outer diameter of the flanges, the casing forming an outer wall of each of the annular chambers and being in rotatable sealing engagement with each of the ring seals to seal the chambers;

the spindle having a lower end wall with a plurality of ports for connection to fixed utility lines in the fixed base of the building for fluid supply to and from the building, and a bore extending from each port through the spindle to a respective annular chamber, whereby each chamber is connected to at least one port in the lower end wall; and

the outer casing having a series of axially spaced ports including at least one port communicating with each of said annular chambers.

2. The apparatus as claimed in claim 1, wherein each flange has an outwardly directed, annular sensor chamber spaced outwardly from the ring seal, the outer casing has a plurality of holes including at least one hole aligned with each of the sensor chambers, and a plurality of fluid sensors are mounted in the outer casing to project through the respective holes to sense any leakage of fluid past any of the seals.

3. The apparatus as claimed in claim 2, wherein one of the annular chambers comprises a sewer chamber for connecting rotating sewer lines within the rotatable building to fixed sewer lines within the base, the spindle having more than one bore communicating with the sewer chamber and the outer casing having a plurality of ports communicating with the sewer chamber.

4. The apparatus as claimed in claim 3, wherein the annular chambers further include a water chamber for supply of water from a fixed water line in the base to water supply lines within the rotating building, and a gray water chamber for connecting at least one gray water drain line within the rotating building to gray water drain outlet line in the base.

5. The apparatus as claimed in claim 4, wherein the annular chambers include a gas supply chamber for connecting a gas supply line in the base to gas supply lines within the rotatable building.

6. The apparatus as claimed in claim 1, wherein the annular flanges include two end flanges at opposite ends of the spindle forming an outer end wall of respective opposite end chambers, and a plurality of spaced intermediate flanges separating adjacent chambers along the length of the spindle, each intermediate flange having a pair of spaced ring seals projecting outwardly from its peripheral edge for rotatable sealing engagement with said outer casing.

7. The apparatus as claimed in claim 6, wherein each intermediate flange has a sensor chamber between the pair of ring seals, and each end flange has a sensor chamber outside the ring seal mounted on the respective end flange, and a plurality of fluid sensors are mounted on the outer casing to extend into the respective sensor chambers to detect leakage of fluid past any of the ring seals, the sensors having outputs for connection to a control unit within the rotatable building to provide an alarm signal in the event of failure of any of the seals.

8. The apparatus as claimed in claim 7, wherein at least two sensors are provided in each sensor chamber.

9. The apparatus as claimed in claim 7, wherein at least one of the annular chambers comprises a gas supply chamber for communicating a gas supply from the fixed base into the rotating part of the building, at least one chamber adjacent the gas supply chamber is a water chamber, and at least one water sensor and one gas sensor is provided in the sensor chamber between the gas supply chamber and water chamber.

10. The apparatus as claimed in claim 1, wherein the fixed spindle and outer casing have upper end walls, and an electrical swivel assembly is mounted on the upper walls of the spindle and outer casing, the electrical swivel assembly comprising a fixed contact core mounted on the upper wall of the fixed spindle and an outer rotating contact portion mounted on the upper wall of the outer casing, the spindle and contact core having aligned central through bores for passageway of fixed electrical power supply lines from the base of the building to the contact core, and the outer contact portion having contacts for connection to power supply lines supplying power to fixtures within the rotating building.

11. The apparatus as claimed in claim 10, including a rotary connector mounted on said electrical swivel for supply of electrical services to the rotating building, the rotary connector having a fixed part for connection to fixed electrical service lines extending through the aligned central through bores of the spindle and electrical contact core, and a rotary part rotatably mounted on the fixed part and having conductors for connection to electrical service lines within the rotating building, the rotary part being coupled to the outer rotating contact portion of the electrical swivel.

12. A rotatable building structure, comprising:

a fixed base;

a building rotatably mounted on the fixed base for rotation about a central axis of rotation coaxial with the building and base;

the building including a central elevator shaft projecting upwardly from the base through the height of the building and having a lower end rotatably mounted on the base;

the base having an outer mounting rail extending in a circular path and spaced outwardly from the elevator shaft;

the building having a lower wall having a series of spaced pairs of bearings running along opposite sides of said mounting rail for rotatable support of the building as it rotates on said base; and

a swivel joint assembly mounted in the base coaxially with said elevator shaft and beneath said lower wall for rotatably connecting fixed utility lines extending into the base with corresponding utility lines secured within the rotating building.

13. The structure as claimed in claim 12, wherein the base has a chamber extending below ground level, the chamber having a drain outlet, the rotatable building having a roof, and a drain line extending from the roof downwardly alongside the elevator shaft and into said chamber, the drain line having an outlet end in said chamber for directing water collected on said roof into said drain outlet.

14. The structure as claimed in claim 13, wherein the swivel joint assembly is mounted in said chamber.

15. The structure as claimed in claim 12, wherein the swivel joint assembly comprises a fixed central spindle secured to the fixed base and having a central axis extending co-axially with the axis of rotation of the building, the spindle having a series of spaced, radially outwardly projecting annular flanges forming a series of outwardly facing annular chambers between said flanges, each flange having an outer peripheral edge and at least one ring seal mounted on said peripheral edge, an outer casing rotatably mounted on said spindle and having a predetermined inner diameter for rotatable sealing engagement with said ring seals, whereby the casing forms an outer wall of each of the annular chambers, the casing being tied to the lower wall of the rotatable building and having at least one through port aligned with each annular chamber, each through port being connected to a respective utility line extending into said rotatable building, and the spindle having a lower end wall having a plurality of bores extending axially parallel to said central axis, including at least one bore terminating in each of said chambers, each bore being connected to a respective fixed utility line in said base.

16. The structure as claimed in claim 15, wherein each flange has an outwardly directed, annular sensor chamber spaced from said ring seal, and the outer casing has a series of sensors including at least one sensor projecting into each of the sensor chambers for detecting leakage past said ring seal.

17. The structure as claimed in claim 16, wherein the flanges including an upper end flange, a lower end flange, and a series of intermediate flanges spaced between said upper and lower end flanges, each end flange having one ring seal and one sensor chamber, and each intermediate flange having a pair

of ring seals with the sensor chamber located between the ring seals, whereby sensors extending into the sensor chambers in respective intermediate flanges detect leakage from the adjacent chambers on opposite sides of said intermediate flanges.

18. The structure as claimed in claim 12, including an electrical swivel assembly mounted on the upper end of the fixed spindle and outer casing, the electrical swivel assembly comprising an inner contact core mounted on the upper end flange of the fixed spindle, and an outer rotating contact portion mounted on the upper end of the outer casing, the spindle and contact core having aligned central through bores, and fixed electrical power supply lines extending from the base of the structure through the aligned central through bore being connected to the inner contact core of the electrical swivel assembly, the outer contact portion having contacts connected to electrical service lines within the rotating building.

19. The structure as claimed in claim 18, wherein the rotating building includes a first set of electrical service lines for transmission of electrical service signals to and from the building, and the swivel assembly includes a rotary electrical connector mounted on said electrical swivel assembly for connection of the first set of electrical service lines to a second set of fixed electrical service lines in the base of the structure, the rotary electrical connector having a fixed part mounted on top of the inner fixed contact core of the electrical swivel assembly and a rotating part rotatably mounted on the fixed part, the rotating part having first contacts connected to said first set of electrical service lines, and the fixed part having second contacts rotatably connected to said first contacts, said second set of fixed electrical service lines including conductive lines extending through said aligned central through bores of said spindle and contact core and connected to said second contacts of said rotary connector.

20. The structure as claimed in claim 19, wherein said rotary electrical connector comprises a low noise mercury swivel.

21. The structure as claimed in claim 12, wherein the mounting rail comprises an inverted T-section rail and the lower wall of the building has a series of spaced wobble boxes, two pairs of bearings being mounted in each of the wobble boxes

and each pair of bearings comprising an inner bearing running along the inside of the rail and an outer bearing running along the outside of the rail.

22. A method of rotatably connecting fixed utility lines beneath a rotatable building to corresponding utility lines secured within the building and rotatable with the building, comprising the steps of:

connecting a plurality of fixed utility lines in a fixed base of a rotatable building to inlet ports at the lower end of a fixed spindle secured to the fixed base and extending co-axially with the axis of rotation of the building, the spindle having a plurality of axially spaced annular chambers defined between annular flanges projecting outwardly from the spindle, each port being connected to a respective chamber;

connecting an outer casing rotatably mounted on the spindle to part of the rotating building so that the casing rotates with the building, the casing forming an outer wall of each of the annular chambers; and

connecting a plurality of utility lines secured within the rotatable building to respective ports in the outer casing, at least one port in the outer casing communicating with each of the annular chambers.

23. The method as claimed in claim 22, including the step of providing at least one seal at the outer peripheral edge of each flange for rotatable sealing engagement with an inner surface of the outer casing to seal each of the annular chambers.

24. The method as claimed in claim 23, including the steps of providing at least one sensor spaced outwardly from each of the seals for detecting fluid leakage past the seal, connecting the outputs of the sensors to a control unit within the rotatable building, and providing an alarm signal in the event of failure of any of the seals.

25. The method as claimed in claim 22, including the steps of mounting an inner fixed contact core of an electrical swivel assembly on top of the fixed spindle, mounting an outer contact portion of the electrical swivel assembly on top of the outer casing, whereby the outer contact portion rotates with the outer casing, connecting a plurality of fixed electrical power lines in the base to the inner contact core via aligned central bores in the spindle and contact core, and

connecting a plurality of electrical power lines within the rotatable building to the outer contact portion of the electrical swivel assembly.

26. The method as claimed in claim 25, including the steps of mounting a fixed part of a low noise rotary electrical connector on top of the fixed contact core of the electrical swivel assembly, connecting contacts on the fixed part to fixed electrical service lines extending from the base through the aligned central bores of the spindle and contact core, and connecting contacts on an upper, rotary part of the rotary electrical connector to electrical service lines secured to electrical devices within the rotatable building, whereby the upper rotary part rotates with the building.